ROAD RANKING AND GUIDELINES FOR A PMS FOR LINDI AND MTWARA REGIONS IN TANZANIA

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SUMMARY

This document sets out a proposal for a ranking system for the rural roads of Lindi and Mtwara Regions in Tanzania and guidelines for a Pavement management System in connection with the road component (Rural Road Rehabilitation and Maintenance, RRM) of the RIPS Programme.

The ranking system is based upon data that already exists and considers factors such as Agricultural output, Transportation (mainly access factors) and Population. These criteria have weights according to their importance and together they supply a value for each road analyzed which gives a ranking order.

The Guidelines for the Pavement Management System mainly considers the data bank of a future PMS. The document also presents some ideas of how to make use of this data. The importance of a computer based data base management system is emphasized due to the amount of data to be collected. Analyses of the data will require the help of computers. Suggestions of incorporating the data collected for the PMS with the Ranking System is also discussed.

The Ranking System will hopefully supply the RRM project with a basis for the selection of those rural roads which do not have an easily determinable priority. The guidelines for a PMS lists parameters on which data should be collected in order to get a working PMS in the future.

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1 BACKGROUND

1.1 General

The economic revitalization of Mtwara and Lindi Regions is most affected by the means of transportation in the regions. The Government of Tanzania (GOT) sees the current road situation as a serious factor affecting the evacuation of agricultural produce. To help the situation a Programme for Transport Sector Recovery as a part of the Economic Recovery Programme was announced in 1987. As a part of the Transport Sector Recovery Programme the GOT introduced a Core Rural Roads Programme which initially involves rehabilitation and maintenance of vital rural roads for the evacuation of agricultural products in seven regions [1].

The Rural Integrated Support Programme in Lindi and Mtwara Regions launched in 1988 aims at improving the living standard in the two regions. An important component of the RIPS programme is the Rural Roads Maintenance and Rehabilitation Project sponsored by FINNIDA [1].

The Rural Roads Rehabilitation and Maintenance Project is a support Project which aims at assisting the sectoral administrations to develop their capacity and capabilities in so that they are able to rehabilitate and maintain the existing system of essential rural roads in cost efficient and sustainable manner and where practicable by labor intensive methods[1].

The project will extend material and technical assistance to the organizations responsible for rural road rehabilitation and maintenance in Mtwara and Lindi Regions. The project will provide necessary equipment, tools and means of transport. The project is also confined to the maintenance and rehabilitation of the current road network. As the funds allocated to the project as well as funds available to the two regions are limited , the project will have to concentrate on essential services[1].

The Resources for the project are such that the not more than 1,000-1,500 km of rural roads will be included in each region. The existing road lengths can be seen in table 1 [1].

Table 1. Road lengths in Mtwara and Lindi Regions

Lindi				Mtwara			
Regional			552	Regional			411
Road Classi-fication	District	Feeder	Total	Road Classi-fication	District Major	District Minor	Total
Lindi	404	95	499	Mtwara	172	611	783
Nachingwea	183	146	329	Newala	208	827	1,035
Liwale	396	64	460	Masasi	237	722	959
Kilwa	508	112	620				
	1,491	417	1,908		617	2,160	2,777
Total (incl. regional roads)			2,460	Total (incl. regional roads)			3,188

1.2 The Road Situation in Mtwara and Lindi Regions

The condition of the roads in Mtwara and Lindi Regions is acceptable where the terrain is flat and the natural soil is suitable at least in the dry season. In the rainy season accessibility is usually restricted where proper drainage and maintenance is lacking. For these roads rehabilitation is needed before maintenance can be effective. The main causes for problems are:

- Steep grades and winding roads on escarpments. This kind of roads require a competently designed and maintained drainage system and erosion resistant surface material.

- Black cotton soils are notoriously poor soils for road building requiring at least 0.5 m of noncohesive fill material and a wearing course. The soil can also be improved by mixing it with sand.
- Other cohesive soils. These kind of soils occur in both regions. They become slippery when wet and can easily get churned up into impassable mud
- Sandy roads. In few areas sand has accumulated making wheel traction difficult. These deficiencies can be overcome by shaping up the road.
- Drainage inadequacies [1].

The flood that occurred in April/May 1990 did not affect the roads as much as could have been expected. It added of course to the general deterioration of the rural roads and made them even more impassable than before.

1.3 Reasons for the Current Situation

The reasons for the current situation as explained above is mainly due to lack of maintenance which in turn is caused by inadequate funding, lack of equipment, spares, fuel, motivation, and proper work procedures[1].

1.4 Consequences if no Actions Will be Taken

During the spring of 1990 a major flood occurred causing damage to roads, drainage structures, but mostly bridges in both regions, the roads have been damaged mainly at bridge approaches. The main concern is that the flood altered the river beds in an extent, that probably will cause flooding even if the next rainy season isn't as bad as that of this year. If another flood will occur during the next rainy season, the roads will probably be more affected than this year. This makes the selection of roads to maintain even more important.

The overall importance of the maintenance project is very high. If the level of maintenance will continue to decline the consequences will be very serious. The decline of the maintenance affects the community as a whole . It will lead to a further decline of agricultural production which sets off a chain of events, the significance of which will be difficult to predict.

Table 2. Existing staff

	LINDI					MTWARA			
	Region	Districts				Region	Districts		
Staff category		Lindi	Kilwa	Liwale	Nachingwea		Mtwara	Newala	Masasi
Regional engineer	1	1	-	-	-	1	-	-	-
Rural roads engineer	1					1			
Trunk Road Engineer	1					1			
Planning Engineer	1					1		-	
Material Engineer	-					1			
Mechanical Engineer	1	-	-	-	-	2			
Technician	3	-	2	2	1	1	-	-	-
Assistant Technician	2	2	1	-	2	3	1	2	2
Techical Auxiliaries	-	3	2	3	6	3	n/a	n/a	n/a
Workshop Superintendent	-	-	-	-	-	9	-	-	-
Technician (workshop)	11	-	-	5	3	13	-	-	2
Technical Assistants (workshop)	11	-	18	2	6		-	4	2
Technical Auxiliaries (workshop)	35	-	-	3	21	20	-	9	20

1.5 Resources Available

The number of staff available for road works and workshops exceed the needed for the present amount of work and should be adequate, for the project, with training. The staff available can be seen in table 2 above [1].

2 THE RANKING SYSTEM

2.1 The Need for a Ranking System

The question of a new ranking system was raised when the proposed system for prioritizing the roads was found inadequate. The proposed system as presented in the Organization & Management Study (see Appendix 12.2 of the RRM Project Preparation Report). The system is based on the total weight of crops to be evacuated (tons) or average daily traffic. This seems to be an appropriate basis for the ranking of these roads, but it has some major deficiencies. The crops evacuated does not represent the total amount produced. Local officials admit to this problem, but there is not very much they can do to repair the situation. The amount of crops transported would surely increase with better road conditions. The increase in crops evacuated can be estimated by using the area cultivated as a criterion. The ADT suggested to be used would have to be counted before even beginning the ranking and even then the data could not predict the possible traffic due to two reasons: the roads that are not used at the moment will probably attract traffic when maintained and made passable and the ADT will in any case be very low, maybe even too low to base any predictions on it. The first reason of the two can be taken into account by estimating the amount of crops, the population and traffic conditions such as passability. The amount of crops should be estimated through cultivated area since the tonnages of today do not represent the harvest that can be evacuated when the transportation of the crops is guaranteed.

2.2 Development of the Criteria

2.21 Collecting the information

Information was collected in Finland on rural road maintenance and on the ranking of those. There seems to exist only a few systems for the ranking of low volume roads, especially for developing countries with very limited resources such as manpower, equipment and funding. One of these is the ranking system presented in the World Bank Staff Appraisal report on the Integrated Roads Project in Tanzania [4].

The factors in the screening method presented in the World Bank report seem adequate but the impact factors are not applicable as far as the crop value is concerned. The crop value takes into account only the crops that actually have been transported out from one area and not how much actually is produced. Data from the co-operative unions suggest clearly the problem with transportation of crops. Also the population factor which is presented as persons per square km does not suggest the density along one specific road. These are the factors that should be taken into account when developing a new ranking system.

The collection of information to base a new ranking system on was made during two trips to Mtwara and Lindi Regions in Tanzania. During the first trip general information on possible road ranking criteria was collected and views of local (Region level) officials were asked for in order to find criteria to be used.

2.211 The First Trip to Tanzania

The first trip to Tanzania to collect general information was made between July 17 and August 5, arriving in Mtwara on July 19.

Criteria for the prioritization was developed. Suggestions for these were made at the Rural Road Maintenance Working Committee Meeting in Lindi on July 23. Criteria that were suggested were: area cultivated, crops produced, forest industry, traffic volume, and number of inhabitants. Suggestions of people to interview on the criteria were also listed at the meeting: e.g. the Cooperative Unions in Mtwara and Lindi, Regional Engineers in Mtwara and Lindi, Regional Development Directors, Regional Agricultural Officers, the Regional Transport Companies and private business men. A list of the people met can be seen in Appendix 1.

Meetings were arranged with people from the organizations mentioned above. The general result of the meetings was that agricultural output would have to be the most significant criteria followed by transportation access and population. Industry as such was not regarded as a major criteria, at least not in the near future since the industry in the area is mainly salt industry which naturally is located along the coastline and can make use of the trunk roads. The areas most important "industry" is agriculture. The list of possible criteria that was introduced to the persons interviewed can be seen in table 3.

The persons interviewed were also asked about the data that they might be able to supply i.e. data on the agricultural output, access factors, tonnages etc. The result was that data would be available for most of the criteria. The criteria that would not have data were 5. Traffic volume and 6. Road data. The latter should be collected in the RRM project.

2.212 The Second Trip

The second trip was made to collect the data that was promised by the different persons. The collection encountered some difficulty, especially in arranging meetings with people met during the first visit. The older data on production when

Table 3. Possible Ranking Criteria for Rural Roads

1. Agricultural output:
- crops:area cultivated (ha) per km of road
- production tons (old and new?)
- new areas to be introduced (cashew nut, coconut)

2. Industry:
- salt production: tons
- saw mills: m^3
- possible oil production
- possible food processing
- possible tourism

3. Population:
- inhabitants per km of road
- planned new population areas, moving trends

4. Transportation:
- access to services: school, health (access, no access)
- access to major road; trunk road, regional road (access, no access)
- road condition (all year round passability, passable during dry season, not passable)
- type of transportation

5. Traffic volume
- old data from when production was high

6. Road data
- road classification (regional, district etc.)
- road roughness classification

it was higher was not available now and the data on cultivated area covers in some cases too large areas. Another slight restriction was the absence of my counterpart. This resulted in a lack of time to gather the necessary data. The data that was gathered was:

- Population for both regions.
- Cultivated area: for Mtwara Region per Division, for Lindi Region only per District.
- Access factors for some of the roads in both Regions.

The data that was collected should be enough to test and determine the weights given to the criteria.

2.22 The Criteria

The criteria to be used are:

- Agricultural output
- Population
- Transportation

Of the criteria suggested industry, traffic volume and road data have been left out due to lack of data. Road data is, however something that is going to be collected, but to which extent and what data is not yet clear. Suggestions for the data to be collected is given in chapter 3. Guidelines for a Pavement Management System.

2.221 Basis for the Criteria

The criteria are mainly based on the interviews made during the first trip to Tanzania and the then proposed criteria, the World Bank Staff Appraisal Report on the Integrated Roads Project in Tanzania [4].

The methodology proposed in the World Bank report is for screening the roads which in the case of Lindi and Mtwara Regions is not directly applicable

Since all of the data that was hoped for was not collected, some criteria have been left out from the proposed ones. These are industry, traffic volume and road condition. These data can be left out with the following justifications:

- The industry located in the two regions is mainly located along the major roads which have a high priority to begin with.
- The traffic volume figures do not exist, and estimates

on these would in no case be accurate. Many of the low-volume earth roads are not even passable so it would be nearly impossible to predict the amount of traffic that these roads would attract when maintained.

- The road condition would normally be the most important determining factors for the ranking of the roads. In this case there is not resources enough to survey all of the roads to gather data before the actions starts. The ranking system proposed is prepared especially with this in mind. One should be able to rank the roads with existing data.

2.222 The Weighing Factors

Improved maintenance of a road can set off a complicated chain of events, that is not well understood. The complexity and factors affected can be seen in figure 1 below. The connections and influences of and between the factors are complex and the number of factors influenced by the road itself are difficult to separate out. The impact on the direct users is easier to sort out and can eventually be calculated from the economic growth of an area. In the case of Lindi and Mtwara regions this will be seen by an increase in agricultural production [6].

The weighing factors are based on the factors mentioned: the nonuser factors are represented by the population criteria and road condition, economical factors by agricultural output and also road condition. The three criteria, Agricultural output, Population, and Transportation, were all considered important by the persons interviewed, the emphasis being on the population and agricultural output. Population has the highest weight due to the fact that this is a factor that has been overseen by previous criteria.

The economic revitalization of the regions concerned will not begin to accelerate if the transportation needs of local

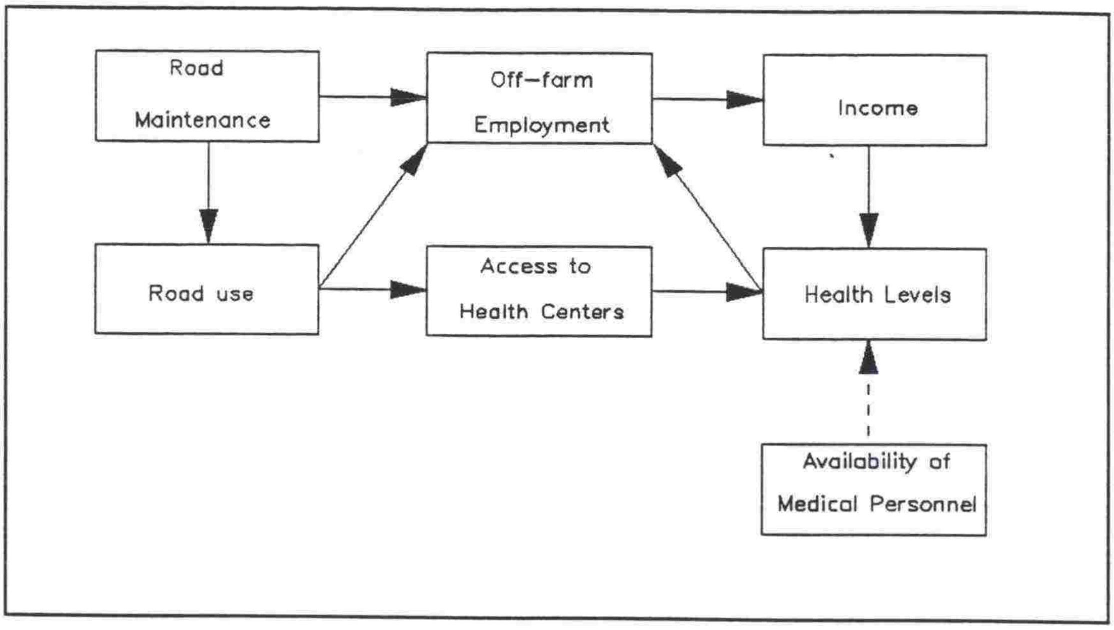


Figure 1. Hypothetical example of relations between road maintenance and some nonuser impacts [6].

people are not taken into consideration. The mobility of the people will help market and production meet on the village level. This brings us to the next most important criteria; the cultivated area. Since all of crops that is produced for selling is not transported out from the villages, the potential of the area is not fully used. This is mainly due to poor road conditions. The cultivated area is a way of expressing the theoretical amount of crops that could be cultivated and also for predicting the transportation needs for that area. The tonnage transported by the co-operative unions give an idea of the percentage of crops not evacuated from an area. The amount of cassava procured and transported in Mtwara Region by the co-operative union give a balance of only 53 % transported and this is caused mainly by road conditions according to the Marketing Manager of Mtwara Region Co-operative Union (MARCU).

The road condition factors as presented in the list of criteria are important mainly in determining the accessibility for vehicles to villages. Most villagers travel by foot which obviously is little affected by the road conditions as such. Road closures of one day or less have little economic impact on the population, but as the interruptions increase in length the impacts become more severe. Disruptions in accessiliblity lasting several weeks, cause closure-induced costs to increase considerably depending on when the disruption occurs. If it occurs in the planting or harvesting period or when insecticides are required, there can be a substantial negative impact on the area's agricultural economy. The impact on non-agricultural trade and social functions is also proportionally greater when the closure continues for several weeks, because the population begins to make longer-term adjustments to the lower level of economic activity. When closures of several weeks are repeated annually there is frequently a reduction in land use intensity or a change in the type of land use, leading to a real loss in area income [5].

Since Lindi and Mtwara regions rely heavily on agriculture, the Transportation and the Cultivated Area criteria suggest the need for accessibility of different areas and provide a basis for ranking the roads accordingly.

2.3 The Ranking System

The ranking system should be used mainly on determining which of the district, feeder or district minor roads are to be maintained. The regional roads should be of top priority in the project due to their general importance as collector roads. These roads are:

- Mtwara-Newala;
- Newala-Masasi;
- Masasi-Lukuledi-Nachingwea;
- Nachingwea-Liwale;
- Liwale-Njinjo-Nanguruguru;
- Nachingwea-Nanganga;
- Newala-Mtama [1].

2.31 The Form to Use

The form to use for the road ranking can be seen in appendix 2. The use of it is very simple: the factors applying to the road section are filled in the value column and are then multiplied with their subweight horizontally. These are added in their own group vertically to form a subtotal and then multiplied with the group weighing horizontally. These values are then finally added to form the ranking value.

When evaluating the values to give the different criteria there are a few specifics that should be taken into consideration.

- The Agricultural output (Ha/km) has to be considered with the help of e.g. the Agricultural Officer in order to get the correct values. The given ranges for the values can and should be adjusted if necessary (for example to suit each district).
- The population value for a certain stretch of road might not always be possible to calculate directly from census figures and should then be estimated by persons acquainted with the area.

There can be a slight difficulty in estimating the cultivated area that a specific road serves, but here again the use of local expertise should be made available.

2.32 Data that Should be Still Collected

The data for the regions is not complete. Data needed to fulfill the ranking is:

For Mtwara Region:

- Transportation factors
- Agricultural output for the whole region per subdivision (ward) if possible.

For Lindi Region:

- Transportation factors for the rest of the roads excluding regional and trunk roads and the most important district roads.
- Agricultural output per ward.

2.33 How Long Should the Model Be Used

The usage of this model as it is can only be justified when data on the roads such as rutting, corrugation, camber/crossfall, potholes etc. has not been collected. When this has been collected they should be used accordingly (see chapter 3). During the collection of road data, factors on road condition can be added to the original ranking system.

3 GUIDELINES FOR A PAVEMENT MANAGEMENT SYSTEM

3.1 Contents of the Guidelines

These guidelines consider mainly the data to be collected for a future pavement management system. The guidelines are based on the OECD Road Monitoring for Maintenance Management, Manual for Developing Countries, Volume 1 and 2. This manual provides a basis for the collection of data on roads by surveying them visually. The method is probably the best considering the limited resources for conducting different bearing tests and other similar requiring both manpower and expensive instruments to carry out. The manual is concentrated on providing a simple guideline for data acquisition on paved and unpaved roads [3].

3.2 Contents of a Pavement Management System

A Pavement Management System (PMS) includes of course more than the collection of data. The data is though a major part of a PMS. The blocks which form the base of a PMS (figure 1) can be described as the :

- Data acquisition;
- Models/Analyses;
- Criteria/Optimization;
- Consequences/Implementation [2].

All these should be supported by a data base system which eventually requires to be computer based. Overall the PMS should give an optimal budget and maintenance plan or state the future (five to ten years) consequences in technical and economic terms of alternative budgets and maintenance strategies. Even an elementary PMS provides a basis for making qualified decisions as to maintenance actions. One

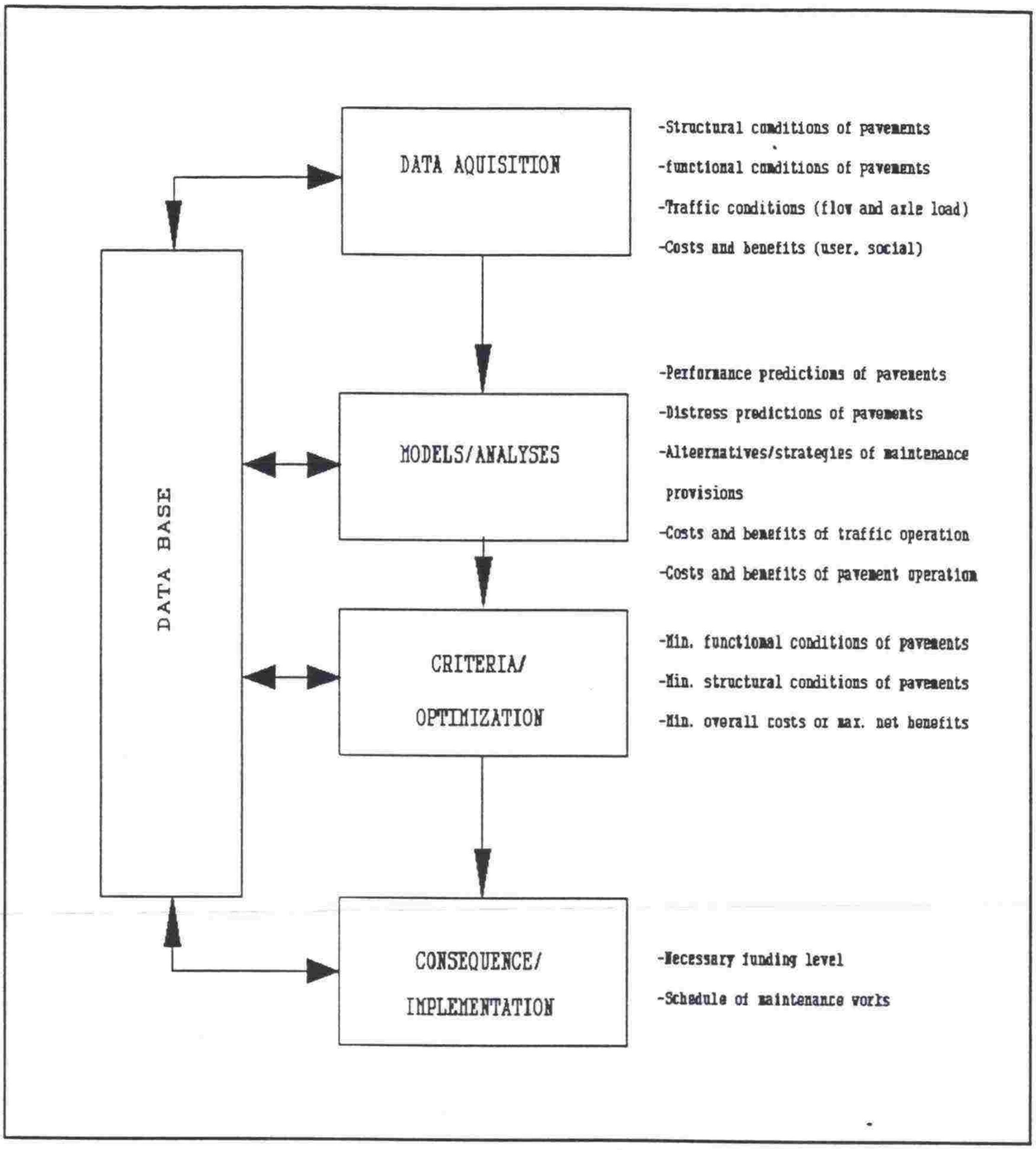


Figure 2. Basic building blocks that characterize a pavement management process

should rather set up an imperfect, simple system than wait until a perfect system has been designed [2].

The PMS can be applied at two levels; the network level, which in Tanzania could be considered as the national level, and the project level, which in the case of Mtwara and Lindi Regions could be considered as the Regional level.

Economically an appropriate PMS should be able to work towards maximizing net benefits subject to constraints. This would include:

a) manage the budget by determining the most appropriate funding level;
b) plan network improvements according to budget requests;
c) determine the effects of deferring maintenance on owner's, the highway authority, and road users' costs;
d) determine the effects on users' cost of raising/lowering the quality standard of road pavements;
e) assure cost-effectiveness through prioritization based on comparison of the costs and benefits of alternatives [2].

Technically, an appropriate PMS should:

a) constitute a comprehensive, efficient data base;
b) learn from past and present facts and figures and improve construction and maintenance techniques,
c) select the best maintenance methods;
d) define problems (defects) and find objective answers to solve these problems;
e) contain an appropriate performance prediction model of pavements to control future performance and evaluate costs benefits of PMS;
f) generate meaningful decision criteria (desirable level, warning level, intervention level of pavement condition) [2].

Administratively, an appropriate PMS should be able to:

a) define the state of road networks rationally;
b) plan or programme maintenance activities of present and future workloads;
c) establish the most efficient monitoring method;
d) determine consequences of different levels of funding on pavement conditions;

e) provide an objective base for political decisions [2].

PMS for minor roads are extremely simplified in their use of objective data acquisition and use of computer programmes due to the lack of economical and technical resources in local administrations [2].

The PMS for rural roads can be considered as stated above as a project-level system. In these systems there is a distinction between alternative project analysis and single project analysis. The former considers several options to maintain or rehabilitate a pavement at a certain time period. A single project analysis concentrates on a specific action or type of work and examines alternative ways of accomplishing that work [2].

3.3 Basis for the Data to be Collected

The major type of data to be collected for a full scale Pavement Management System include the following elements:

1) Structural conditions of pavements.
   - Construction history
   - Geometric data
   - Soil data
   - Drainage characteristics
   - Surface distresses
   - Structural distress- deflection

2) Functional condition of pavements
   - Longitudinal evenness
   - Transverse evenness
   - Skid resistance
   - Surface texture
   - Surface impermeability
   - Noise generation properties

3) Traffic conditions
   - Traffic surveys
   - Travel time
   - Accident inventory concerning road conditions, driver conditions, circumstances, injuries, material damages.

4) Costs and benefits
   - Maintenance costs
   - User costs such as: vehicle ownership and vehicle operating costs, accidents, travel time
   - Social costs (traffic disruption, accident costs, noise, pollution) [2].

The data to collect for low volume roads should be less extensive due to the lack of resources and also because the maintenance actions on earth and gravel roads are simpler. The maintenance for low-volume roads consist mainly of the following actions:

- Routine maintenance;
- Grading at regular intervals;
- Rehabilitation with earth surface;
- Rehabilitation with gravel followed by periodic regravelling;
- Rehabilitation with bituminous concrete [1].

3.31 What to collect

Management of a road network requires different information at different levels of decision-making (i.e. for planning, programming, design and implementation). The data to be collected (what, how and when) by an inspection system depends largely on the use of the data. The two main management applications are:

- Maintenance management, the aim of which is the efficient organization, scheduling and budget-control of maintenance activities within the budget or fiscal year; in formal systems this often includes assessment of the effectiveness of the works and the productivity rates.

- Pavement management; a procedure that minimizes the whole life cost of the road and requires information on the condition and trafficking of the pavement, in order to evaluate and schedule appropriate major maintenance or rehabilitation works, in both medium-term and yearly programmes [3].

There are two important components in both processes; the information and the decision process, the first one being the basis for the second one. The extent of data to be collected depends mainly on the resources available and on the capabilities of the road administration. The road monitoring system presented in the OECD manual provides a two-level data collection system. The first level, called a Road Condition Survey (RCS), provides basic information for the whole road network and would be conducted annually. The second level, the Detailed Visual Inspection (DVI), is a more detailed survey which would be used for sections appearing to need major work. Both surveys are visual and require some training and experience of road maintenance. The flowchart for the road monitoring can be seen in picture 4 [3].

The data to be gathered are the same as the parameters that are evaluated in the Road Condition Survey and the Detailed Visual Survey. The parameters for the RCS are:

- Carriageway:	Surface quality Prevailing damage (if necessary)
- Shoulders:	Deformation Scour
- Side drains:	Siltation Scour
- Road space:	Debris/vegetation encroachment Obstacles/obstructions
- Road signs & markings:	furniture; road Dirty and/or damaged, missing

FLOW CHART OF THE ROAD MONITORING SYSTEM AND ITS INTERACTION WITH PLANNING AND PROGRAMMING MAINTENANCE ACTIVITIES

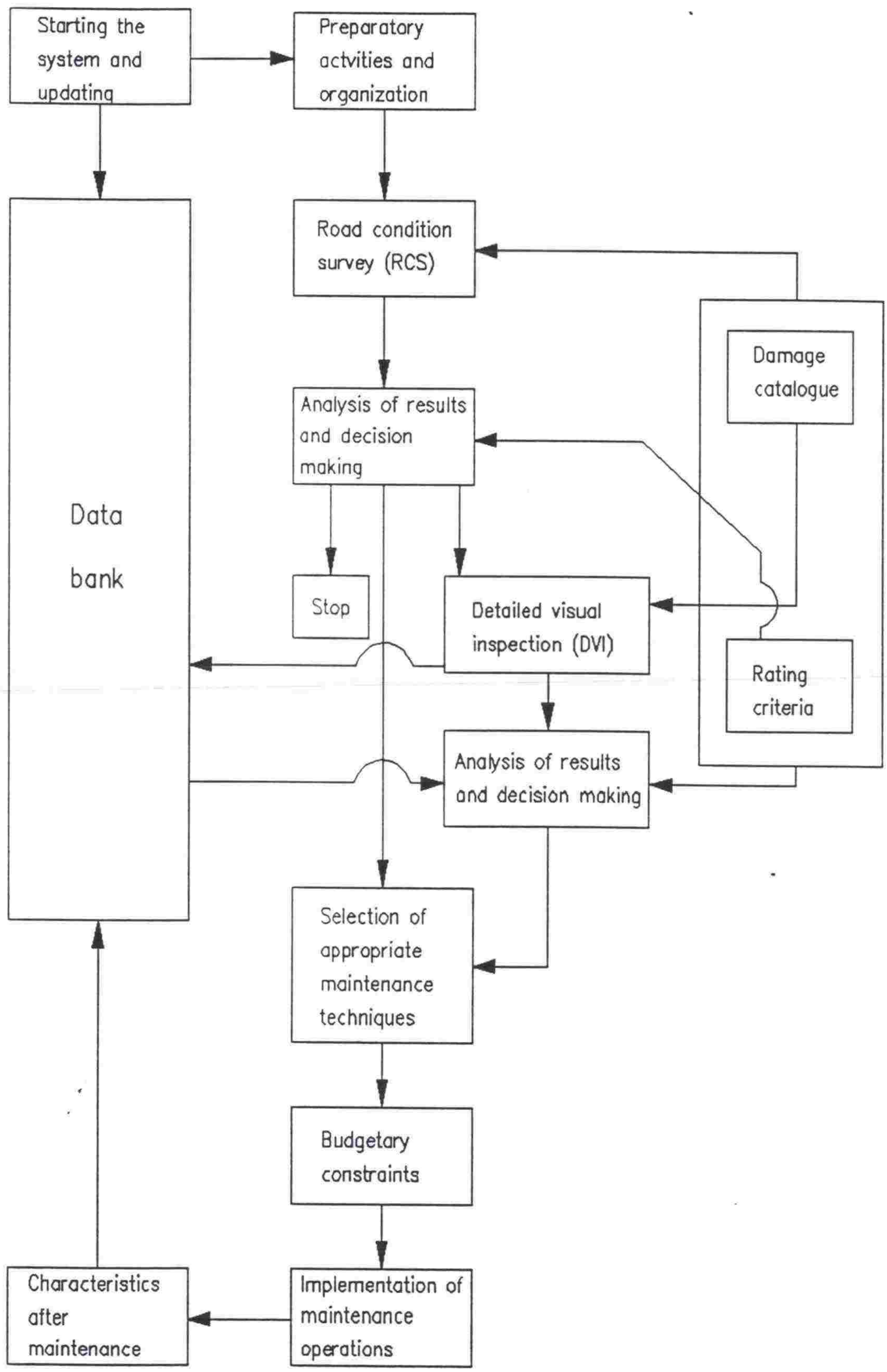


Figure 3. Flow chart for the Road Monitoring System

- Culverts: Silted/blocked
  Scour
  Structural damage
- Bridges: Silted/blocked
  Scour
  Structural damage
- Damage and defects to be repaired immediately [3].

The parameters to evaluate for the Detailed Visual Inspection for **unpaved** roads are:

- Rutting;
- Corrugations;
- Camber/crossfall;

- Gravel thickness;
- Erosion gullies;
- Potholes;

- Clay [3].

For DVI of **paved** roads the parameters are:

- Rutting without cracks;
- Rutting with cracks;
- Corrugations;
- Depressions;

- Transverse cracks;
- Longitudinal cracks;
- Alligator cracks;

- Holes;
- Edge distress;
- Stripping/fretting/ravelling;
- Stripping/fretting/ravelling of surface [3].

3.32 Requirements for the data collection and the establishing of a road monitoring scheme

The basic requirements for a well-organized data collection for a PMS are the following:

- A division of the road network into sections and sub-sections. These should be as homogenous as possible.
- Every section and sub-section must be defined by a simple code comprising of road, section, and sub-section number.
- A standardized system of data collection (the Road Monitoring for Maintenance Management) [3].

The knowledge of the functional characteristics of the roads is needed in order to divide the road into sections and sub-sections. The functional classification of the roads can be based on the following criteria:

- Traffic load. i.e. annual average daily traffic (AADT) or, if available, the daily number of heavy traffic.
- Road category, i.e. primary, secondary, tertiary roads or similar.

An example of this can be seen in table 4 [3].

Table 4. An example of a functional evaluation of roads [3].

Criteria	Class	Functional indicator	
		Paved roads	Unpaved roads
Traffic (AADT)	1	> 1000	> 200
	2	200 - 1000	50 - 200
	3	< 200	< 50
Road category	A	Primary or main road	
	B	Secondary or feeder road	
	C	Tertiary or local road	

The road classification has to be indicated on a map before proceeding to the next step: the division into sections. The large scale map must be transformed into a simplified road map which is used to divide the roads into sections and sub-sections. The sub-sections should be homogenous in character with regard to: cross-section, pavement structure (as far as is recognizable), environment (e.g. cut, fill, open country, forest, village, gradient, etc.). The length of the sub-sections should not be less than 500 m, unless there are special reasons for the introduction of shorter sub-sections. On the other hand it should not exceed 5 km. The length of sections depends on the length of the sub-sections. The section should not consist of more than five sub-sections. Sections should be chosen logically, i.e. between villages, major intersections, bridges, etc. Inspection will be facilitated if strip maps of the sections and sub-sections are prepared. These maps can give a lot of information about

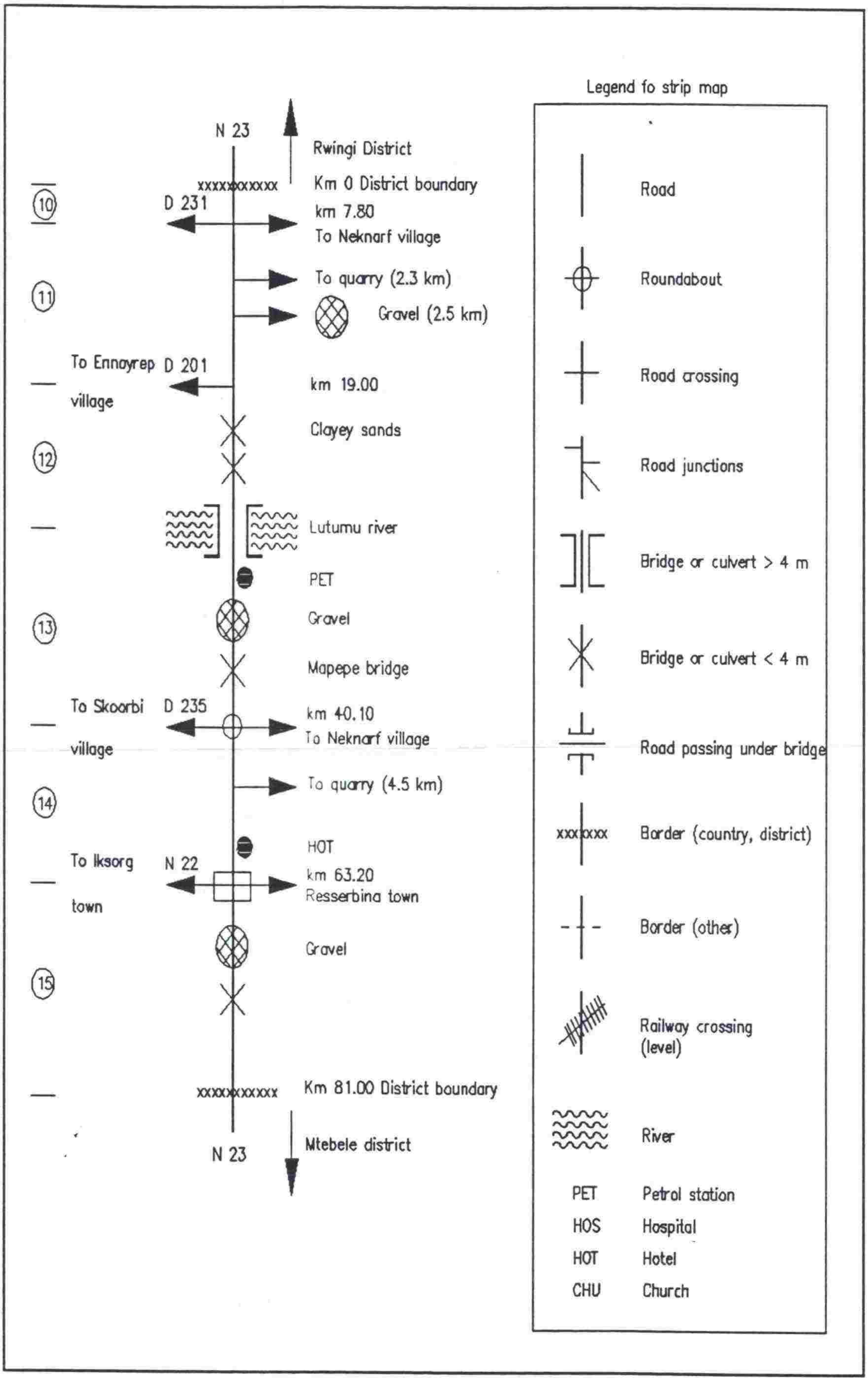


Figure 4. Strip map of road N 23

the sections and sub-sections and ensure better inspection of culverts and other small structures. Strip maps should contain among other information the following (figure 4):

* Location of culverts and bridges;
* Location of quarries and borrow pits and the length of access roads to quarries and borrow pits;
* Location of intersections,
* Chainage [3].

The strip maps could be done even before the ranking of the roads since they would provide some of the information needed to rank the roads in Lindi and Mtwara Regions. The data that could be added is the agricultural criteria (Ha/km) for each "strip".

3.4 Organization of the Monitoring

The monitoring system is, as stated earlier, based on two levels of inspection:

1. The Road Condition Survey (RCS)

2. The Detailed Visual Inspection (DVI)

The RCS should be conducted over the entire road network, but where resources are limited, as in Mtwara and Lindi Regions, representative sections should be chosen. These sections should be sampled throughout the network and selected on the basis of age, traffic, structure and environment in order to provide long term performance evaluation data which could be useful for modelling road deterioration. The road ranking system could preferably be used to select the roads for inspection [3].

The DVI should be conducted at least on those sections that were identified by the RCS to be in need of major maintenance. In order to conduct the surveys in the most economical way, daily itineraries should be prepared by the regional (or district) office.

3.41 Resources needed

The resources needed for the inspections depends on the frequency required of the surveys and the way the inspection teams are organized. The daily itinerary for a road condition survey could be of a total length of 30-50 km. per day. For the detailed visual survey it could be 5-8 km per day. For day to day operations the manual suggests that the team would consist of one driver, one or two observers and a maintenance engineer. The maintenance engineer is mainly needed during the detailed visual inspections. He must have a good practical knowledge of road maintenance [3].

In Mtwara and Lindi Regions, the observer could at first be the Rural Roads or Trunk Roads Engineer and the team would thus require a minimum of two persons to carry out the surveys: a driver (who preferably would also be trained for the surveying and have some experience of road maintenance) and the Rural Roads or Trunk Roads Engineer. When an other observer (e.g. the driver) has been trained, the maintenance engineer would be required only for the detailed visual survey and the Road Condition Survey could be carried out by only one person although this is not very recommendable. The need of a vehicle is of course obvious and it should be big enough to transport the equipment listed below [3].

The equipment needed is the following: a four wheel drive vehicle, a measuring wheel or a measuring chain in order to establish chainage and distances, a straight edge (2 m) and a calibrated wedge to measure rut depth and alike, a shovel, a pick-axe and a camera. The pick-axe and shovel are used to determine the depth of the surface layer of gravel roads.

More sophisticated instruments can be used for the Detailed Visual Inspection, but is not needed to get started [3].

3.42 Training needed

The key personnel for the road monitoring system are the regional engineer and the road maintenance engineer. The training programme needs to be designed for these to:

- Enhance their recognition of the need for improved maintenance procedures;
- Develop a positive attitude toward the monitoring system;
- Improve technical ability and skill [3].

The amount of training needed should be evaluated separately. The OECD Road Monitoring Manual presents some training packages for different key personnel

3.5 The use of the data

The data collected in the road surveys should be checked for its accuracy before put to any use. The checking should be done either by the unit performing the inspections or at a management level in close contact with the field. The inspection forms or route diagrams summarizing the inspection results may provide excellent means for the validation process [3].

A requirement for the validation is that the data has been collected and entered using a common referencing system [3].

The data has to be filed in Lindi and Mtwara regions simply in filing cabinets due to the lack of computers. The files should contain for example the completed route diagrams or inspection diagrams. A limitation of a manual filing system is of course that updating and analyzing the data can be tedious, particularly when the road network is extensive.

3.51 The Use of the Data Today

The data that has been collected can be used for basically three different processing types:

- Technical processing involving the preparation of overall analysis to facilitate work scheduling.
- Statistical processing involving the production of various specific statistics relating to one or more types of data (histograms, correlations, regressions)
- Data aggregation [3].

The technical processing which is the most common type can include generation of route diagrams giving a summary of all data on a given subject, e.g. traffic operation, road safety, road maintenance of which the latter is of greatest importance for Lindi and Mtwara Regions[3].

Statistical processing include item counts and histograms, correlation and regression. The item count could for example be the total length of road with surface dressing. This could be done manually, but further processing would require the use of computers [3].

The data can be used to form a global index to represent the overall condition of a road or the road network. This can be useful for reporting at network level but it has been found inadequate for scheduling maintenance works. As a minimum it is best to report the condition with at least two parameters: roughness and surface distress [3].

The aggregation of data for evaluating pavement condition and work programmes can be divided into three levels:

- That required by decision-makers who have use for general indicators by which to monitor pavement quality, mainly in order to assess the service provided or , in some cases the value of the existing infrastructure;
- That required by a centralized agency that needs to assess long-term maintenance requirements, to draw up general work schedules and allocate funds where they are needed, and to rank proposals by

order of priority and urgency;

- That required by field engineers who have to produce detailed work plans [3].

The simplest aggregate rating of condition is into three or more categories such as good, fair and poor. But to be meaningful, these categories need to be defined by physical levels of distress, and to be related to traffic levels or service standards [3].

There are two accepted methods of presenting the aggregate data:

- The first is to show the ratings for a given year on a map, so as to depict pavements in relation to their condition; this method simply shows routes with different level of service, and difference from one geographic area to another;
- The second method involves plotting histograms, bar charts or "pie" charts showing the percentage of roads providing good or poor level of service; these are used mainly to compare results at different points in time, to show good or bad trends in level of service [3].

There are several existing rating standards which can be used for the condition rating such as the International Roughness Index (IRI). The IRI considers roughness which is maybe the most important aspect of condition affecting the level of service to the user and the economic benefits to be derived from maintenance [3]. Other factors not directly related to pavement surface condition such as trafficability ("Transportation" in the Ranking System) can influence the definition of service provided. In Lindi and Mtwara Regions trafficability is an essential factor to consider.

3.6 Future possibilities

3.61 Establishing a Full Scale PMS

The OECD PMS Report presents several steps in the establishing of a full scale Pavement Management System that are based on experiences in its' member countries. The steps apply also for developing countries although the emphasis on different steps may vary.

The following steps are generally included when implementing a pavement management system:

- Deciding to install a pavement management system: this decision must be based on an assessment of the needs and the anticipated benefits;
- Defining the objectives and the scope of the PMS taking into account the existing pavement management approach and needs for improvement;
- Defining the required pavement management system, i.e. the major phases and components of the system
- Developing a general schedule for installation;
- Deciding which phases are to be done internally and which are to be done by contractors. This division of labor is based on the existing capability of the organization and cost;
- The setting up of a the required administrative structure;
- Defining the required data elements to assess the pavement condition, including the survey process and the periodic monitoring procedures;
- Defining a road or street system by segment and functional class;
- Creating an appropriate data bank for pavement management;
- Developing quality standards for road and street construction and maintenance (riding quality, structural adequacy, pavement condition, etc.9;
- Developing prediction models of pavement

performance;

- Devising a priority programming method, including the formulation and evaluation of maintenance alternatives at both network and project levels;
- Developing a system to assure feedback from data collected and assessed in order to improve design, specification, quality control, construction and maintenance procedures [2].

Many of the steps mentioned above would be carried out simultaneously and iteratively over a number of years. Some of the steps are included in the Road Monitoring for Maintenance Management such as defining the road system by segment and functional class and the survey process and periodic monitoring procedures. The decision of installing a pavement management system, defining the objectives and scope of the PMS and the major phases and components of the system will be done on a national level. The actual creating of maybe the most important part of the PMS, the data bank, will be done on a Regional level.

The most important steps for Lindi and Mtwara Regions are to define a road system by segment and functional class and to start creating the data bank for a Pavement Management System. There is a slight risk in using the OECD Road Monitoring System to create the data base which is the risk that a national level PMS will be founded on data slightly different. The OECD is however preparing a PMS Manual which should be based on the Road Monitoring System and this would hopefully be taken into consideration when establishing a nationwide PMS

3.62 Computerization

Computerization is almost a requirement in order to be able to efficiently make use of the data that has been collected. The main function of a computer data base system is:

- To store the collected data
- To analyze
- To optimize and
- To evaluate the consequences.

The use of a database management program that has been tailored to fit the needs of a PMS makes the handling of the data easy and the production of yearly reports on for example road condition almost automatic.

The greatest advantage is to be able to process the data statistically and thereby to gain knowledge about pavement performance. The study of trends in pavement behavior and condition, relative to conditions such as weather, traffic and structural design makes it possible to acquire an objective view of the quality of methods used in designing new pavements and strengthening or maintaining existing ones and also to analyze alternative maintenance strategies on the basis of a life cycle analysis of maintenance costs.

Ingredients in a road data-bank system are:

- Definitions of the data elements available in the road data bank, and corresponding regulations that provide precise instructions on how each and every piece of information of the road network has to be measured.
- A system for referencing data to location on the site.
- Data base files
- Database Management Systems to retrieve, process, and present information stored in the bank.
- A system for updating the files of the bank.
- An organization, including regulations about the operation and responsibilities [2].

Questions that are raised while laying out the concept of a road data bank are: should all the available data elements be incorporated prior to the definition of applications, or should applications first be defined , and only those data be gathered which are required for these applications? The bank would be continually modified according to user demand.

another question raised is can the bank be considered an aid to management with control available to central administration on a priority basis or would it be a means for locally responsible engineers at the most elementary level of management for the purpose of establishing work schedule proposals, or both ?[2]

Experience in this field suggest that it is preferable to establish the road data bank on specifically defined objectives, while providing for the means of subsequent incorporation of additional objectives. An authentic bank must be an evolutionary system which can incorporate new data at any given moment (where required) without creating a disturbance at the entire assembly level [2].

3.63 Adding Factors to the Ranking System

The guidelines for the PMS consider mainly the data to be collected. The collection of the data should be started with the most useful part which is road condition and should be done using the Road Monitoring Manuals Road Condition Survey. The RCS includes, as described above, parameters such as surface quality, shoulder deformation an scour of side drains. This is data that can be added to the ranking system or used as replacement for some other criteria. In fact the Ranking System can be developed to a simple Pavement Management System by adding more parameters evaluated in the RCS and the DVI. The only actual problem is to decide on the weights of these new criteria in comparison with the earlier ones or those left out.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Evaluation of the Ranking System

The criteria presented for the ranking of the rural roads in Lindi and Mtwara Regions should be well suited for their purpose. The ranking of the roads will be a rather tedious job for in order to succeed, all of the roads which do not have a predetermined priority (mainly the regional roads) have to be evaluated. Since there are no computers to be used at the moment the results have to be recorded manually and also calculated manually. This is though work that has to be done in order to be able to rank the roads.

The model itself lacks as already stated information on road condition such as rutting, ravelling etc. This is information that successively can be added to the system when the collection of it has been started. In fact this data should be added to the system in the near future in order to make the ranking of the roads closer to a simple PMS and thus letting it gradually develop into a PMS.

A problem that may arise is that if or when a national Pavement Management System will be developed, the ranking model, if developed, might prove to be based on factors other than those suggested on a national level. The data to be collected using the Road Monitoring for Maintenance Management Manual should be adequate data to base any future PMS on [3].

Some general but important aspects of the implementation of a Road Data Bank:

- Specific resources should be attributed to this task;
- The overall responsibility for the data bank should be clearly assigned, and preferably to managers of the highest-priority activity that draws on its resources;
- An adequate reference system (strip-maps) for defining each data element in space and time must

be in place;

- For each data element collected and recorded, care should be taken to assure that: a) the data will be put to good use; b) data are well-defined and measured by a standard procedure; c) an updating system is established and responsibility for updating lodged with the user most keen on having the data element [2].

4.2 Further Development

The model should be supplemented with road condition information in the near future. In that way the model could work as an intermediate "lightweight" PMS before the collection of data is extensive enough to be put to the use of a Pavement Management System run by a computer.

The development into a Pavement Management System will be a question on national level since the system to use has to be a national one. Therefore there is a risk that some of the data collected using the road monitoring system cannot be used and that additional data has to be collected. The OECD is, however, working on a pavement management manual for developing countries which is based on the road monitoring manual.

A question that may be encountered when collecting data is the necessity of compiling a data base with detailed information when the maintenance actions in general are simple and decisions could be made on site for different projects. Although this may be true, the actual question of how to use the limited resources in the most efficient way can only be answered by looking at the different projects on a regional level and this is where the use of a pavement management system proves its worth. As stated above experience show that even the use of a very simple decision system, which provide a basis for the decisions, will help to use available funds in a more rational way.

5 REFERENCES

1. Rural Integrated Project Support (RIPS) In Lindi and Mtwara Regions. Project document for Rural Road Rehabilitation and Maintenance. May 1990

2. Pavement Management Systems. Report prepared by an OECD scientific expert group. Paris 1987. 159 pp.

3. Road Monitoring for Maintenance Management. Manual for Developing countries. OECD. Paris 1990.

4. World Bank Staff Appraisal Report. The united Republic of Tanzania. Integrated Roads Project. April 1990.

5. Rural transport Services, A guide to their Planning and Implementation. Henri l. Beenhakker et al. Intermediate Technology Publications. London 1987. 379 pp.

6. Road Project Appraisal for Developing Countries. John W. Dickey and Leon H. Miller. John Wiley & Sons. London 1984.

APPENDIX 1. Persons met in Tanzania

Persons met in Lindi:

Ujensi:

Regional Engineer: Mr. Kijagi

Trunk Road engineer: Mr. Chibandikile

Building engineer: Mr. Ndege

Rural Roads Engineer: Mr. Okuli

Cooperative Union: Mr. P. Lukanda, Marketing Manager

Regional Planning Officer: Mr. D. Sufratigavo

Regional Agricultural Officer and Crops Officer: Mr. P. Nyassi

Private businessman: Mr. Sameja

Natural Resources Officer: Mr. Sunega

Regional Forest Officer: Mr. A. Mgheni

Persons met in Mtwara:

Ujensi:

Regional Engineer: Mr. Mlaponi

Materials Engineer: Mr. Nkini (counterpart of Mr Molin)

Rural Roads Engineer: Mr. Kilowoko

Planning and Programming Engineer: Mr. Makele

MARCU (Mtwara Region Cooperative Union): Mr. A. N. E. Mchauni, General Manager and Mr S. Namkuna, Marketing Manager

Regional Planning Officer: Mr. Kimaro

Regional Agricultural Officer an Livestock Officer: Mr A. Mwenkalley

ReTCo (Mtwara Regional Transport Company): Mr. B. Gasper

Private businessmen: Mr. Abasi, Mr. Mulji

RIPS Project Coordinator: Mr. I. Ledje

Regional National Resources Officer: Mr. R. Maganga

Regional Forest Officer: Mr. S. Mosayamjilo

Persons met in Dar es Salaam:

Ministry of Communication and Works: Mr. Chiwanga and Mr. Byabato

APPENDIX 2. The form to use for the Road Ranking System

ROAD INFORMATION		
Region:	Road Classification:	From:
		Via:
District:		
	Km:	To:

CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70				
Tons	1-3	0.30				
					30	
Population						
Inhabitants	1-3	1.00				
					40	
Transportation						
Access to major road	1-3	0.20				
Road Condition	1-3	0.25				
Road condition at						
harvest time	1-2	0.30				
Access to services	1-3	0.25				
					15	
Industry						
Production	1-5	1.00				
					15	
TOTAL		1.0			100	

APPENDIX 3. Examples of forms used for some roads in Kilwa District in Lindi Region

From:	To:	Rank Value:	Rank:
Kipatimu	Kibata	218,25	3
Kipatimu	Hanga	169,25	5
Nainokwe	Liwiti	195,55	4
Njinjo	Nandete	248,75	2
Ngea	Nandete	264,75	1
Migeregere	Njinjo	101,5	7
Somanga Nd	Mingumbi	159,5	6

The values above are based on the information acquired from the regional Engineer in Lindi and the Regional Agricutural and Crops Officer. The values include some inaccuracy due to the cultivated area figures, which were given only per district and not per ward. The ranking values which are close to each other should thus be considered equal.

ROAD INFORMATION						
Region:	**Road Classification:**			**From:**	Kipatimu	
Lindi				Via:		
District:						
Kilwa	**Km:**	16		**To:**	Kibata	
CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70	2	1.4		
Tons	1-3	0.30	2	0.6		
				2	30	60
Population						
Inhabitants	1-3	1.00	3	3		
				3	40	120
Transportation						
Access to major road	1-3	0.25	2	0.5		
Road Condition	1-3	0.25	2	0.5		
Road condition at harvest time	1-2	0.30	1	0.3		
Access to services	1-3	0.25	1	0.25		
				1.55	15	23.25
Industry						
Production	1-5	1.00	1	1		
				1	15	15
TOTAL		1.0			100	218.25

ROAD INFORMATION						
Region:	Road Classification:			From: Kipatimu		
Lindi				Via:		
District:						
Kilwa	Km:	20		To: Hanga		
CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70	2	1.4		
Tons	1-3	0.30	1	0.3		
				1.7	30	51
Population						
Inhabitants	1-3	1.00	2	2		
				2	40	80
Transportation						
Access to major road	1-3	0.25	2	0.5		
Road Condition	1-3	0.25	2	0.5		
Road condition at						
harvest time	1-2	0.30	1	0.3		
Access to services	1-3	0.25	1	0.25		
				1.55	15	23.25
Industry						
Production	1-5	1.00	1	1		
				1	15	15
TOTAL		1.0			100	169.25

ROAD INFORMATION						
Region: Lindi	**Road Classification:**			**From:** Nainokwe		
				Via:		
District: Kilwa	**Km:**		8	**To:** Liwiti		
CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70	3	2.1		
Tons	1-3	0.30	2	0.6		
				2.7	30	81
Population						
Inhabitants	1-3	1.00	2	2		
				2	40	80
Transportation						
Access to major road	1-3	0.25	1	0.25		
Road Condition	1-3	0.25	2	0.5		
Road condition at harvest time	1-2	0.30	1	0.3		
Access to services	1-3	0.25	1	0.25		
				1.3	15	19.5
Industry						
Production	1-5	1.00	1	1		
				1	15	15
TOTAL		1.0			100	195.5

ROAD INFORMATION

REGION: Lindi	**Road Classification:**	**From:**	Njinjo-Mpopora-Kandawale-Ngarambi-
District: Kilwa	**Km:** 98	**To:**	Nandete

CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70	3	2.1		
Tons	1-3	0.30	2	0.6		
				2.7	30	81
Population						
Inhabitants	1-3	1.00	2	2		
				2	40	80
Transportation						
Access to major road	1-3	0.25	2	0.5		
Road Condition	1-3	0.25	2	0.5		
Road condition at harvest time	1-2	0.30	2	0.6		
Access to services	1-3	0.25	1	0.25		
				1.85	15	27.75
Industry						
Production	1-5	1.00	4	4		
				4	15	60
TOTAL		1.0			100	248.75

ROAD INFORMATION						
REGION:	Road Classification:			From:	Ngea-	
Lindi				Via:	Mitole-Mkarango-	
District:					Kipatimu-	
Kilwa	Km:	56		To:	Nandete	
CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70	4	2.8		
Tons	1-3	0.30	2	0.6		
				3.4	30	102
Population						
Inhabitants	1-3	1.00	3	3		
				3	40	120
Transportation						
Access to major road	1-3	0.25	2	0.5		
Road Condition	1-3	0.25	2	0.5		
Road condition at harvest time	1-2	0.30	2	0.6		
Access to services	1-3	0.25	1	0.25		
				1.85	15	27.75
Industry						
Production	1-5	1.00	1	1		
				1	15	15
TOTAL		1.0			100	264.75

ROAD INFORMATION						
Region:	Road Classification:			From:	Migeregere	
Lindi				Via:	Ruhatwe-Kikole-	
District:					Mitole-	
Kilwa	Km:		40	To:	Njinjo	

CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70	1	0.7		
Tons	1-3	0.30	2	0.6		
				1.3	30	39
Population						
Inhabitants	1-3	0.70	1	0.7		
				0.7	40	28
Transportation						
Access to major road	1-3	0.25	1	0.25		
Road Condition	1-3	0.25	2	0.5		
Road condition at harvest time	1-2	0.30	1	0.3		
Access to services	1-3	0.25	1	0.25		
				1.3	15	19.5
Industry						
Production	1-5	1.00	1	1		
				1	15	15
TOTAL		1.0			100	101.5

ROAD INFORMATION						
Region: Lindi	Road Classification:			From: Somanga Ndumbo-		
District: Kilwa				Via: Kinjumbi-Kikema-Mtyalambuko-Chapita-		
	Km: 45			To: Mingumbi		
CRITERIA	RANGE	SUB-WEIGHT	VALUE	SUB-TOTAL	WEIGHT	TOTAL
Agricultural Output						
Ha/km	1-5	0.70	1	0.7		
Tons	1-3	0.30	1	0.3		
				1	30	30
Population						
Inhabitants	1-3	1.00	2	2		
				2	40	80
Transportation						
Access to major road	1-3	0.25	1	0.25		
Road Condition	1-3	0.25	2	0.5		
Road condition at harvest time	1-2	0.30	1	0.3		
Access to services	1-3	0.25	1	0.25		
				1.3	15	19.5
Industry						
Production	1-5	1.00	2	2		
				2	15	30
TOTAL		1.0			100	159.5

APPENDIX 4. The criteria for the Road Ranking System

Ranking Criteria

		Weight (%)
1. Agricultural output		30
Ha/km"(1-5)	70	
Tons (1-3)	30	
2. Population		40
Inhabitants/km (1-3)	70	
New population areas (1-2)	30	
3. Transportation		15
Access to major road (1-3)	15	
Road condition (1-3)	15	
Road condition at harvest		
Time (1-2)	50	
Access to services (1-3)	20	
4. Industry		15
Salt production (1-5)	100	

1. Agricultural output:

Ha/km:	1	0-50
	2	51-100
	3	101-150
	4	151-200
	5	201-
Tons:	1	0-50
	2	51-100
	3	101-

2. Population:

Inhabitants/km:	1	Less than average
	2	Average
	3	More than average

3. Transportation:

Access to major road:	1	Access with any vehicle
	2	Access with four wheel drive or tractor
	3	No access with vehicle
Road condition:	1	Passable all year round
	2	Passable during dry season
	3	Not passable
Road condition in connection to harvest time:	1	Road passable during harvest season
	2	Road not passable during harvest season
Access to services:		
	1	Access

	2	No access

4. Industry:

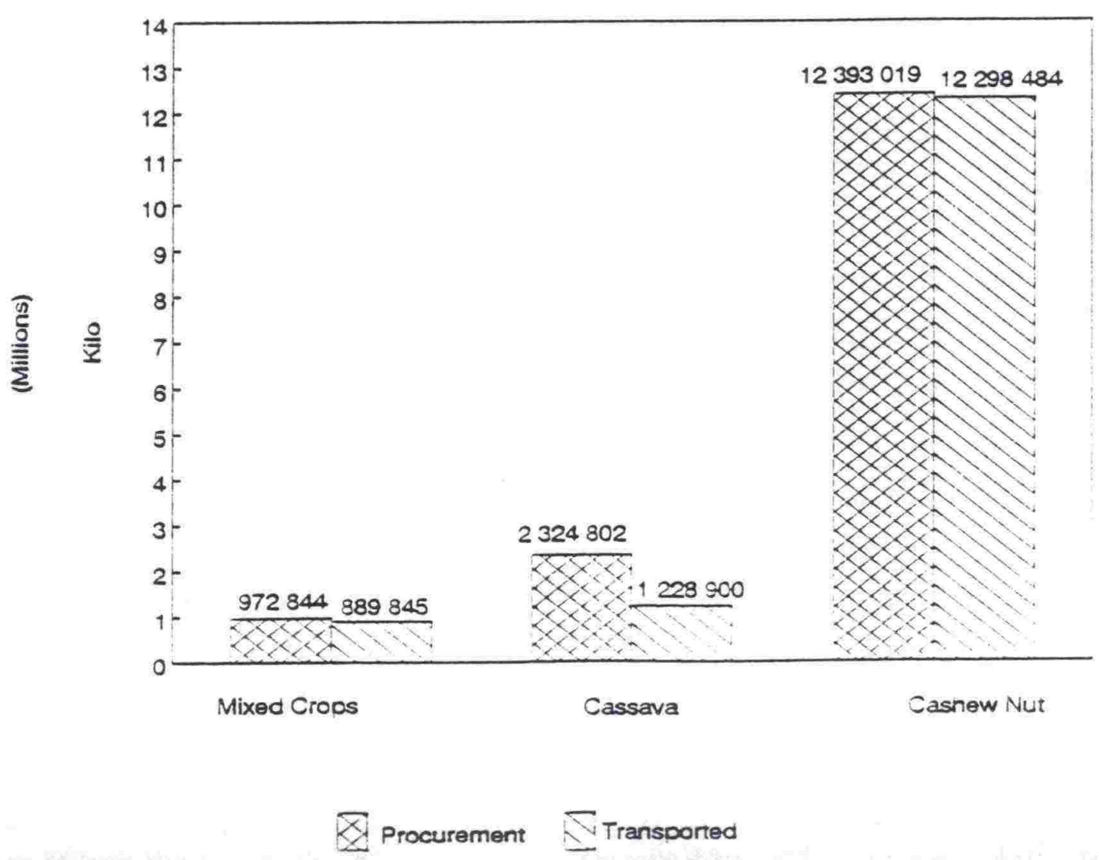
Salt tons	1	0-200
	2	201-500
	3	501-

Appendix 5. Data from Mtwara Regional Co-operative Union

Mtwara Region Co-operative Union 1988/89

District

Mixed Crops	Procurement (Kilo)	Transported (Kilo)	Balance (Kilo)
Mtwara	328189	312254	15935
Masasi	367927	333476	24451
Newala	276728	244115	32613
Total	**972844**	**889845**	**82999**
	Percent transported (%)		**91.5**
Cassava			
Mtwara	1672312	1128300	544012
Newala	652490	100600	551890
Total	**2324802**	**1228900**	**1095902**
	Percent transported (%)		**52.9**
Cashew nut			
Total	12393019	12298484	94535
	Percent transported (%)		**99.2**



FORM FOR SURVEY (RCS) OR INSPECTION (DVI) ITINERARY "FORM I"

MAINTENANCE DISTRICT: MOROKULI Completed by: A. MUTALI	Itinerary No.: 2	PAGE 1

ROUTE: Identification points (I.P.) Kind	Designation	MAIN SECTIONS: Road Class	No.	No. of main section	Chainage (km)	Length Single (km)	Length Added (km)
1	2	3	4	5	6	7	8
V	080/Ennoryep	D	201	1	223.50	7.05	
J	022				216.45		7.05
J	022	N	23	11	216.45	5.50	
C	021				210.95		12.55
C	021	N	23	10	210.95	5.95	
L	020				205.00		18.50
C	021	D	231	3	12.00	10.50	
CT	090				22.50		29.00
CT	090	D	231	4	22.50	7.25	
B	089				29.75		36.25
B	089	D	231	5	29.75	8.45	
V	060				38.20		44.70
V	060	D	231	6	38.20	9.05	
L	088				47.25		53.75
V	060	D	235	3	33.35	10.35	
CC	097				23.00		64.10
CC	097	D	235	2	23.00	14.90	
C	024				8.10		79.00
C	024	D	235	1	8.10	8.10	
J	095				0.00		87.10

Sub-sections

Number of sub-sections	① From	① To / ② From	② To / ③ From	③ To / ④ From	④ To / ⑤ From	⑤ To	No. of main section
IP	V	CV	CC	CP	J		1
Station	223.50	222.00	218.55	217.35	216.45		
Length (km)	1.50	3.45	1.20	0.90			
IP	J	B	C				11
Station	216.45	214.35	210.95				
Length (km)	2.10	3.40					
IP	C	CV	CV	L			10
Station	210.95	209.70	207.85	205.00			
Length (km)	1.25	1.85	2.85				
IP	C	CV	CV	B	CV	CT	3
Station	12.00	14.50	15.25	18.50	20.15	22.50	
Length (km)	2.50	0.75	3.25	1.65	2.35		
IP	CT	CV	CV	CC	B		4
Station	22.50	23.65	24.85	26.50	29.75		
Length (km)	1.15	1.20	1.65	3.25			
IP	B	CC	CV	V			5
Station	29.75	34.45	36.65	38.20			
Length (km)	4.70	2.20	1.55				
IP	V	CV	CC	CV	CV	L	6
Station	38.20	39.65	41.85	44.55	46.35	47.25	
Length (km)	1.45	2.20	2.70	1.80	0.90		
IP	V	CT	CV	CV	CV	CC	3
Station	33.35	30.15	28.45	26.95	24.65	23.00	
Length (km)	3.20	1.70	1.50	2.30	1.65		
IP	CC	B	CV	V	V	C	2
Station	23.00	19.95	18.85	14.15	9.65	8.10	
Length (km)	3.05	1.10	4.70	4.50	1.55		
IP	C	B	CV	J			1
Station	8.10	5.35	4.85	0.00			
Length (km)	2.75	0.50	4.85				

WORK FORM FOR SURVEY (RCS) OR INSPECTION (DVI) ITINERARY "FORM I"

MAINTENANCE DISTRICT: MOROKULI Completed by: A. MUTALI	Itinerary No.: 2	PAGE 2

ROUTE: Identification points (I.P.) Kind	Designation	MAIN SECTIONS: Road Class	Road No.	No. of main section	Chainage (km)	Length Single (km)	Length Added (km)
1	2	3	4	5	6	7	8
C	024	N	23	13	237.55	6.50	87.10
CP	023				231.05		93.60
CP	023	N	23	12	231.05	14.60	
J	022				216.45		108.20

Sub-sections

Number of sub-sections	1 From – To	2 From – To	3 From – To	4 From – To	5 From – To	No. of main section
IP	C	CV	CV	CP		13
Station	237.55	234.95	233.65	231.05		
Length (km)	2.60	1.30	2.60			
IP	CP	CV	B	CV	J	12
Station	231.05	227.95	226.35	224.15	216.45	
Length (km)	3.10	1.60	220	7.70		
IP						
Station						
Length (km)						

ROAD CONDITION SURVEY (RCS) FORM ("FORM II")

ROAD CONDITION SURVEY PAVED AND UNPAVED ROADS		ROAD DENOMINATION / CLASS: D 201	Main Section No.
		FROM: 080 (Ennoryep)	Km: 223.50
		TO: 022	Km: 216.45
OFFICE: R.MAINT	DISTRICT: MOROKULI	Pavement type: DST / Pavement width: 6.50 m	Section length: 7.05 Km
Name of inspector: J. Mbanaw		Summary (Avg. Condition)	Carriageway: 25 : B = 3.125
Date: 88 0120	Weather: ☒ Clear ○ Rainy; Carr.way: ○ Dry ☒ Drying ○ Wet		Road side elements: (2.2 + 1.8 + 2.2 + 1.5) / 4=1.9
			Remarks:

SUB-SECTION	1		2		3		4		5	
Chainage of sub-section	223.50		222.00		218.55		217.35		216.45	
Roadside	L	R	L	R	L	R	L	R	L	R
Carriageway	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5	1 2 4 3 5
Prevailing damage	CL	PO	CA	PO	CA	CL	CA	CL		

ROAD SIDE ELEMENTS — Damage type	L	R	L	R	L	R	L	R	L	R
Shoulder — Deformation RCS1	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Shoulder — Scour RCS2	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Side drains — Siltation RCS3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Side drains — Scour RCS4	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Debris/Vegetation Encroachment RCS5	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Obstacles/ Obstructions RCS6	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Average Condition (Others)	11 + 15 = 26		7 + 15 = 22		10 + 16 = 26		9 + 9 = 18		+	=
	26 : 12 = 2.2		22 : 12 = 1.8		26 : 12 = 2.2		18 : 12 = 1.5		:	=

ROADSIGNS/FURNITURE — Chainage	223.05	219.95	221.35	215.55	216.15	216.45				
	L	R	L	R	L	R				
Dirty RCS7	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Damaged RCS7	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
Missing RCS7	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

REMARKS: 1) D.V.I. required (average > 3.0) for this section

2) Road furniture at 216.45 to be repaired / replaced

CONDITION SURVEY FORM FOR STRUCTURES ("FORM III")

ROAD CONDITION SURVEY (RCS)

OFFICE: R.D. MAINT.	DISTRICT: MOROKULI	PAGE	1
Name of inspector: J.Mbanaw			
Date: 88 01 20	Weather x Clear o Rainy		

STRUCTURES				CONDITION SURVEY						
Road denomination/Class:										
Type of structure	Main section	Sub-section	Chainage	Silted/ Blocked L	Silted/ Blocked R	Scour L	Scour R	Structural Damage L	Structural Damage R	Notes/Remarks
Culvert ø 200cm	1	.1	222.00	1	2	3	2	1	1	
Culvert ø 80 cm	1	.3	218.25	2	2	1	1	1	1	
Culvert ø 80 cm	1	.3	218.15	2	2	1	1	1	1	
Culvert ø 80 cm	1	.4	217.15	1	2	2	2	1	1	
Bridge 5 m span	1	.4	216.50	1	1	2	1	1	3	road kerbs to be replaced
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	
				1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	

SUMMARY OF ROAD CONDITION SURVEY RESULTS: AVERAGE CONDITION VALUE ("FORM IV")

ROAD CONDITION SURVEY (RCS) PAVED AND UNPAVED ROADS

OFFICE: R.D. MAINT.	DISTRICT: MOROKULI		PAGE 1
Established by: MUTALI			
Date: 88 01 21			

DESIGNATION OF ROAD SECTION

Road		Section No.	Identification Points (IP)			Section length	Pavement width	AADT
Class	No.		I.P.	Designation	Km	Km	m	Veh/day
1	2	3	4	5	6	7	8	9
D	201	1	From V	080 (Ennoryep)	From 223.50	7.05	6.50	300
			To J	022	To 216.45			
			From		From			
			To		To			
			From		From			
			To		To			
			From		From			
			To		To			
			From		From			
			To		To			
			From		From			
			To		To			
			From		From			
			To		To			
			From		From			
			To		To			
			From		From			
			To		To			
			From		From			
			To		To			

SURVEY DATA

Avg. condition value		Road signs & Furniture	Notes / Remarks
Carriageway	Road side elements		
11	12	13	14
3.125	1.9		DVI required

DETAILED VISUAL INSPECTION FORM FOR PAVED ROADS ("FORM VII")

DETAILED VISUAL INSPECTION (DVI)			PAVED ROADS	
OFFICE: R.D. MAINT.	DISTRICT: MOROKULI	ROAD DENOMINATION / CLASS: D201		Main Section No. 1
Name of inspector:		FROM I.P.: 080 (Ennoryep)		Km: 223.50
Date: 88 01 23	Weather: x Clear, o Rainy; Carr.way: x Dry, o Drying, o Wet	TO I.P.: 022		Km: 216.45
		Pavement type: DST	Pavement width: 6.50	Section length: 7.05Km

SUB-SECTION		1						2						3						4						5					
Roadside		L			R			L			R			L			R			L			R			L			R		
Damage type - Cat	E \ S	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S
Rutting - PR1	<10%	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
	10-50%	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5
	>50%	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5
Corrugations - PR2	<10%	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4
	10-50%	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5
	>50%	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5
Depressions - PR3	<10%	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4
	10-50%	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5
	>50%	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5
Transverse cracking - PR4a	<2 (No./100m)	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4
	2-15	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5
	>15	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5
Longitudinal cracking - PR4b	<10%	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
	10-50%	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5
	>50%	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5
Alligator cracking - PR4c	<10%	1	4	5	1	4	5	1	4	5	1	4	5	1	4	5	1	4	5	1	4	5	1	4	5	1	4	5	1	4	5
	10-50%	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5
	>50%	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5
Holes - PR5	<5 (No./100m)	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
	5-15	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5
	≥15	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5	4	5	5
Edge distress - PR6	<10%	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4	1	3	4
	10-50%	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5	2	3	5
	>50%	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5
Stripping/ Fretting/ Ravelling - PR7a	<10%	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4	1	2	4
	10-50%	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
	>50%	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5
Stripping/Fretting/ Ravelling of surface - PR7b	<15%	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	15-30%	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5
	>30%	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5	3	5	5
Bleeding - PR8	< 5%	1			1			1			1			1			1			1			1			1			1		
	5-50%	2			2			2			2			2			2			2			2			2			2		
	>50%	3			3			3			3			3			3			3			3			3			3		

Remarks: